RELATIONSHIP OF ECONOMIES OF SCALE (EOS) FACTORS FOR MALAYSIAN INDUSTRIALISED BUILDING SYSTEM (IBS) PRECAST MANUFACTURER

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DEDICATION

Dedicated to my beloved parents:

Tajul Ariffin bin Mohd Idris

Junaidah bt Bolia

Zakaria bin Abdullah

Zainab bt Md Hassan

My beloved husband,

Mohd Amin bin Zakaria

My siblings,

My friends,

Akhawat,

Who offered me unconditional love and support throughout the course of this study

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ABSTRACT

Industrialised Building System (IBS) or prefabrication has been identified as one of the key methods to reduce construction cost and gain financial benefits. The characteristic of controlled production and systematic process in the IBS manufacturing is helpful in quality production and profit generation. A structured financial guideline can assist IBS manufacturers to maximise the production of IBS components and gain competitive advantage. The economy of scale (EOS) is one of the available strategies for IBS manufacturers to reduce average cost and increase the level of production. However, many IBS manufacturers fail due to lack of understanding in EOS and limited of study in Malaysia. Therefore, this study has noted a gap of knowledge to examine the EOS for IBS manufacturers. This study aims to establish the EOS factors for precast manufacturers using quantitative method. In the first phase, a systematic literature review and interviews were used to assist and validate the collected factors. In the second phase, the questionnaire survey was conducted to collect data from the precast manufacturers. In the light of findings, 10 factors were noted significant and were further categorised into internal and external factors. The internal factors of EOS were technical, financial, labour, managerial, marketing, commerce, and core competence. While the external factors of precast manufacturers consist of risk bearing, external industry, and infrastructure factors. IBS manufacturers can use this study as a reference to assess the possibilities of their business expansion. The good combination of production factors (as can be referred to the framework of EOS factors for precast manufacturer) and existing mass production can effectively distribute the fixed cost and lead to economical production. In addition, the developed framework can assist the manufacturers in the development of planning and organising the operational process to sustain their business for a long period of time.

ABSTRAK

Sistem Bangunan Industri (IBS) atau kaedah pasang siap telah dikenalpasti sebagai salah satu kaedah utama untuk mengurangkan kos pembinaan dan mendapat manfaat kewangan. Ciri pengeluaran yang dikawal dan proses sistematik dalam pembuatan IBS membantu dalam pengeluaran produk yang berkualiti dan menguntungkan. Garis panduan kewangan berstruktur boleh membantu pengeluar IBS untuk memaksimumkan pengeluaran komponen IBS dan mendapat kelebihan daya saing. Skala ekonomi (EOS) adalah salah satu strategi yang tersedia kepada pengeluar IBS untuk mengurangkan kos purata dan meningkatkan tahap pengeluaran. Walau bagaimanapun, banyak pengeluar IBS gagal kerana kurang memahami EOS dan kajian ini terhad di Malaysia. Oleh itu, kajian ini mengemukakan jurang pengetahuan untuk mengkaji EOS untuk pengeluar IBS. Kajian ini bertujuan untuk menubuhkan faktor-faktor EOS untuk pengilang pratuang dengan menggunakan kaedah kuantitatif. Pada fasa pertama, kaedah kajian literatur dan temubual digunakan untuk membantu dan mengesahkanfaktor yang dikumpul. Pada fasa kedua, tinjauan soal selidik telah dijalankan untuk mengumpul data daripada pengeluar pratuang. Berdasarkan penemuan, 10 faktor telah dikenal pasti dan dikategorikan kepada faktor dalaman dan luaran. Faktor dalaman EOS adalah teknikal, kewangan, buruh, pengurusan, pemasaran, komersil, dan kecekapan teras. Sementara itu, faktor luaran terdiri daripada faktor risiko, industri luaran, dan faktor infrastruktur. Pengeluar IBS boleh menggunakan kajian ini sebagai rujukan untuk menilai kemungkinan pengembangan perniagaan mereka. Gabungan yang baik daripada faktor pengeluaran (rujuk kerangka faktor EOS untuk pengeluar pratuang) dan pengeluaran besar-besaran yang sedia ada secara efektif dapat mengagihkan kos tetap dan membawa kepada pengeluaran ekonomi. Di samping itu, rangka kerja yang dibangunkan dapat membantu dalam pembangunan perancangan dan mengatur proses operasi untuk mengekalkan perniagaan untuk jangka waktu yang panjang.

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LIST OF SYMBOLS AND ABBREVIATIONS

CAD	-	Computer-Aided Design
CAPEX	-	Capital Expenditure
CIDB	-	Construction Industry Development Board of Malaysia
CIPAA	-	Construction Industry Payment and Adjudication Act
CITP	-	Construction Industry Transformation Programme
CNC	-	Computer Numerical Control
DEOS	-	Dis-Economies of Scale
DETR	-	Department of the Environment, Transport and Regions
EOS	-	Economies of Scale
GDP	-	Gross Domestic Product
GNI	-	Gross National Income
GFCF	-	Gross Fixed Capital Formation
IBS	-	Industrialised Building System
IRB	-	Inland Revenue Board
ITA	-	Investment Tax Allowance
LRT	-	Light Rail Transit
MIDA	-	Malaysian Investment Development Authority
MITI	-	Ministry of International Trade and Industry
MLT	-	Multi-Layered Thematic
MP	-	Malaysia Plan
MRT	-	Mass Rapid Transit
OECD	-	Organisation for Economic Cooperation and Development
OPEX	-	Operational Expenditure
PIA	-	Promotion of Investment Act 1986
RAPID	-	Refinery and Petrochemical Integrated Development Project
R & D	-	Research and Development
SME	-	Small and Medium Enterprise
SPSS	-	Statistical Package for the Social Science
VVCT	-	Verification, Validation, Certification and Testing

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Construction industries play a vital role in the economic growth of nations. As facilities and infrastructures are the basic needs to accommodate the demand of local communities. While in developing countries, such as Malaysia, there are challenges in the construction industry which can create uncertainty in the global economy, improved Economic Transformation Programme, and to enhance productivity. Due to the reasons, in the Eleventh Malaysia (2016 - 2020), productivity is being upheld as renewed effort towards national, industry and enterprise economy. According to productivity report of 2016/ 2017, Malaysia's productivity performance was expanded up to 3.5 % growth. While, the targeted of productivity level in 2020 is 3.7 % growth (Malaysia Productivity Corporation (MPC), 2017). This reflects that the rigorous efforts were made to ensure the achievement in the economic development.

In Malaysia, the government greatly promotes the implementation of prefabrication technology, which is known as Industrialised Building System (IBS) towards the enhancement of productivity in the construction industry with the cooperation of the Construction Industry Development Board (CIDB), IBS Centre and Malaysian Investment Development Authority (MIDA). The function of MIDA organisation is to assist the IBS manufacturers in the production of material, components and supply chain (MIDA, 2015a). The IBS manufacturing was introduced since last 50 years ago with intentions to increase its usage. As reported by the MIDA in December 2015, 210 IBS manufacturers were registered with the

Construction Industry Development Board (CIDB) for certification of components, companies and installer (MIDA, 2015a).

The competitiveness in manufacturing industry is essential to increase the performance in achieving economic sustainability, improvement in equipment efficiency and reducing the production disturbance (Ingemansson & Bolmsjo, 2004). According to CREAM (2011), the main criteria for the selection of new IBS manufacturing site are cost, market access, and infrastructure. This is because, the cost of selecting manufacturer is high and this strategy can ensure the capabilities to sustain for long term in developing new IBS manufacturer. IBS manufactures are also need to properly design and manage their production process to ensure the quality of components toward the green construction. According to CIDB (2015b), there are some issues that almost every manufacturer is facing such as; high cost of import duty for IBS manufacturing equipment, lack of management practices and experiences, and lack of economies of scale (EOS) in production. From these, it can be assume that, the material, technology and management of construction are important to manage for the economic fit in the construction cycle (Yusof & Omar, 2007). Besides this, the IBS is not just a technological solution, but a holistic process which needs rationalisation, standardisation, collaboration from the construction practitioner, better supply chain, more effective planning, and project management (Kamar et al., 2012).

Report on Roadmap IBS for 2011-2015 stated a low volume and EOS in the production of IBS due to non-standardised and demand. The contractors have requested for different size of components and projects that require investment in new moulds (Minister of Works, 2010). This nature of demand, give non-economical production. However, the trend of mass production requires the customisation of products and services that can lead to lower cost (Pham, Pham, & Thomas, 2008). For example, Coca-Cola Corporation has successfully implemented EOS in their production (Ambrose, Highfield, &Linneman, 2000). However, there are limited references in EOS in production. Therefore, holistic manufacturing strategies must be developed in order to ensure that the future development in manufacturing is able to meet the IBS demand.

The concept of EOS, which theoretically based on two major variables namely, cost and output is visualised in short and long run average cost curve graph. As the firm grow, the increase in return of scale are obtained as the good combination of

factors of production such as labour, capital, and materials can effect on optimum of scale production (Vengedasalam, Karunagaran, & Rohana, 2008). Since the objective of EOS is to reduce cost while increasing output, their implementation in manufacturing industry had given benefits to the business in terms of competitive advantage and productivity (Pukeliene & Maksvytien, 2008). Furthermore, EOS is a good strategy for producing a large volume of goods and obtains efficiency in operations (Ruddock, 2009). Therefore, this research intends to propose the theory of EOS for the IBS manufacturers industry so that manufacturing companies can become economically stable.

1.2 Problem statement

The challenges in the construction are commonly known as the issues of project delay, wastage of resources, lack of communication and coordination, low quality, and rework. Therefore, in promoting the usage of IBS, under the Construction Industry Transformation Programme (CITP) 2016-2020, CIDB targeted to have an additional of 100 IBS Manufacturers in order to expand the construction industry in Malaysia, and enhancing the usages of IBS (Abas, 2016). Unfortunately, the high cost of IBS components lead to low demand and develop negative perceptions among the developer, consultant, and contractor. As the growing numbers of IBS manufacturers, the applications of IBS in construction are still rare. As reported in News Strait Times on May 11, 2015b, by the Deputy Chief Executive Officer of Malaysian Investment Development Authority (MIDA), the adoption of IBS in Malaysian construction industry is still unsatisfactory and represents about 15-20 percent of the overall projects. IBS that give a significant impact in the construction industry, are able to reduce the overall construction cost, construction time, and wastages which produce better quality of construction, and increasing construction's safety (Kamar, Alshawi, & Hamid, 2009; Majid et al., 2011; Kamar, Azman, & Nawi, 2014). Although IBS presents a lot of benefits to the construction industry, but the contractors show reluctant in shift to implement the IBS due to economic issues (Rahman & Omar, 2006). This problem normally occurs on small and medium contractors, who face the cash flow problem to use the IBS system in construction (Kamar et al., 2009).

There are some IBS manufacturer challenges which highlighted by CIDB (2015b), and lack of demand of few IBS manufacturers due to cost of import duty for IBS manufacturing equipment's, installation of machineries are rather expensive, lack of skill in management, IBS manufacturer location is sparse and transportation for components are costly. Besides this, the IBS manufacturer faces lack of training practise, lack of skill labour, lack of guideline in the design component, readiness from the construction practitioner, method of payment, and low quantity of demand give no EOS return (Lou & Kamar, 2012). Likewise, Majid et al. (2011), also agreed that one of the factors that contribute to the low usage of IBS is the high price of IBS components, and it needs to be produced in large numbers to minimise the cost of production. According to Musa et al., (2014), cost with effect of EOS in manufacturing, are obtained by modular component with repeated component units.

The cost can be reduced accordingly with the increment of output to the point of dis-economies of scale (DEOS) (Ariffin, Yunus, Mohammad, & Yaman, 2016). Thus, without proper application of EOS throughout the production process, reduction of cost is unlikely to happen. It was also supported by Mao, Shen, Luo & Li (2015) who found that the pressure of higher cost in IBS manufacturing occur since there are no holistic EOS applied. There are also other factors that can beneath the EOS for better execution. For example, the effective usages of technical and economic efficiencies in the business, lead to maximise in growth performance of the firm (Celli, 2015). With regard to the bumiputera IBS manufacturers, these factors were arguably not been fully exploited by them, thus making the price of IBS components is still costly (Ariffin, Yunus, Mohammad, & Yaman, 2017). While, Nanyam et al. (2017) have stated that the comparison cost of precast component is 15 to 30 % more expensive as compared to conventional construction. They suggested the conductions of more studies to provide a clear understanding of IBS benefits especially in the financial issues.

Notably, due to the lack of studies specifically on EOS for IBS manufacturer, a quandary of knowledge gap has observed. Therefore, it is a pertinent to recognise the holistic factors that may influence EOS towards IBS manufacturers in Malaysian context. The research is optimistic that the infusion of total EOS concept in IBS manufacturing would promote reasonable price of IBS components, and will further encourage the contractors' towards implementation which simultaneously geared up to accomplish the national agendas. Therefore, this study was conducted to identify

the factors of EOS which can be used as a useful reference for the IBS manufacturing practice. Based on the problem statement, four research questions have been identified as follows:

1. What are the factors that influence the EOS for generic manufacturing?
2. Do the factors that influence the EOS for generic manufacturers is applicable towards Malaysian IBS manufacturers?
3. How significant the factors that influence the EOS towards Malaysian IBS manufacturers?
4. What is the relationship of the factors that influence the EOS towards Malaysian IBS manufacturers?

1.3 Objectives of the study

The purpose of the research is to establish the EOS's factors relationship specifically for Malaysian IBS manufacturers as a term of reference. Therefore, the research gap, research questions and objectives are outlined in the Table 1.1 for ease of reference.

Table 1.1: The research gap, research questions and objectives

Research Gap	Research Questions	Objectives
There is lack of knowledge specifically on EOS for IBS manufacturer	What are the factors that influence the EOS for generic manufacturing?	1. To identify the EOS factors. 1a) Identify the factors that influence the EOS for generic manufacturing. 1b) Validate the EOS factors towards Malaysian IBS manufacturers.
	Do the factors that influence the EOS for generic manufacturers are applicable towards Malaysian IBS manufacturers?	
	How significant the factors that influence the EOS towards Malaysian precast manufacturers?	2. To analyse the significance of the EOS factors for Malaysian precast manufacturers
	What is the relationship of the factors that influence the EOS towards Malaysian precast manufacturers?	3. To analyse the relationship of EOS factors in precast manufacturers.

1.4 Scope of study

This study has focussed on the establishment of factors that related to the concept of EOS within the precast manufacturer industry. Hence, an exclusive perspective of Malaysia's precast manufacturer is being chosen as the scope of research. This is because there are some questions that required a specific unit in the production capacity. Precast type of IBS also is the major component used as there are many IBS manufacture compare to others type of IBS (Azman et al., 2011). Therefore, the collected data has focussed toward one type of IBS. The phases involve in this research are more focused on the manufacturer of IBS component in the yard and on-site. However, the other relating phase of input is important towards the development of IBS. The respondents involved in this study are purposely from the top level of management in IBS manufacturer, production manager, and personnel involved with most of the production processes. The scope considered is starting from manufacturing to finishing.

Data collections consist of extensive literature, semi-structured interviews, and questionnaires survey that were conducted to enhance the finding to answer the come up research questions and fulfil the objectives. The survey was conducted widely in peninsular Malaysia.

1.5 Limitation of study

There are some limitations that were recognised during the research work. First, in construction, the usage of all types of IBS gives a successful development in the project. Each type of IBS gives different functions and manufacturers. However, in this study, the precast IBS was focused as the component that hugely produced in off or on-site.

Secondly, for the respondent and methodology, the scope of data has provided for a single respondent from the precast firm. The sample survey was limited so the readers should be cautious in the generalisation of data findings. Besides this, the selection of the analysis has used some simple and traditional method. The framework cannot be analysed by statistical equation method (SEM) due to small sample size.

Thirdly, the methodology to get the economic findings was short due to period of time. The application of the theory of EOS and the capabilities of framework design were not fully explored.

1.6 Significance of the study

This research was expected to collect the valuable EOS factors that can give benefits in terms of maintaining the monetary gain to IBS manufacturers. Most companies generally have a number of objectives which aiming to survive and success in their business. Manufacturing firms are exposed to experience greater competition given the technological advancement in manufacturing. Under such a turbulent climate, the configuration and effective deployment of manufacturing strategies are imperative to increase the business performance. An effective strategy in the company operational can make companies more competitive in the market place, creating employment in a sector that has witnessed to decline growth in unemployment (Ehie & Muogboh, 2006). Therefore, an organisation or a company needs to succeed in their business to remain in a competitive business environment (Arslan & Kivrak, 2008). The existence of EOS theory and its use in the construction industry is less than expected. EOS has the advantage to gain positive revenue and made long-run productivity growth (Ambrose et al., 2000). Truett & Truett (2007) provide a good example in applying EOS to determine the cost advantages in both short and long-term. The application of EOS was adopted in the manufacturing of automobile industry in France. The relationships for related factors, such as capital, labour, domestic, and intermediate goods are being investigated to know the cost price elasticity relation (a measure of the responsiveness of quantity demanded or supplied of the good) toward factors by using a trans log cost function. Then, the nature of EOS and dis-economies in output level are being identified. This can lead to strengthening the firm competitive advantages and increase the economic results (Pukeliene & Maksvytiene, 2008). The EOS also helps to improve the IBS manufacturer environment that leads to mass production and component standardisation which result in gaining economic production and profit. Therefore, this study is important to provide an understanding of the economic scale and benefits toward precast IBS manufacturers. From the factors collected, some shade of the holistic approach platform can be viewed in the decision making and self-assessment for the

manufacturers to benefit from EOS. Based on Harun & Ishak (2014), firms generally focus on labour and capital as to produce goods and services, however, there are other factors that might able to maximise the production which sometimes the producers cannot identify the appropriate resources. Compared with previous research that focuses on technical or economic aspects, this research extends existing knowledge on construction prefabrication to the concept of production factors in EOS along with the manufacturing process. It also covers industry characteristics of developing countries, as represented by Malaysia's scenarios. Therefore, this might able to assist them to sustain in long term and highly competitive industry.

1.7 Outline of the thesis

This thesis was outlined in five chapters as shown briefly below:

Chapter 1: This chapter comprises the background of this study and on the IBS issues that give the direction in defining aim and objectives. The scope, limitations of study, and significance of studies that give direction are the parts of this chapter.

Chapter 2: The reviews of some important keyword are important to enhance understandings that correspond to the previous research study. Starting from the construction industry, followed by IBS, and precast manufacturing were determined in this chapter. The general manufacturing concept also was reviewed. The concept of EOS was determined and lead to the collection of EOS factors.

Chapter 3: The research design and methodology was developed according to the defined objectives. In the first phase, the literature was analysed to collect the generic EOS factors. Then, the interview method was used in phase 2 to validate these factors. Next, the questionnaires were distributed among IBS precast manufacturers and finally the correlation and Kruskal Wallis H analysis were determined to generalise data among the respondents.

Chapter 4: This chapter consists of result and analysis, which describe the response rate, data results from close ended and open-ended questions of the interviews, and the results of survey questionnaires. The significance and relationship of the factors were identified in this chapter.

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